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**BRL**

RADIO TELETYPE OPERATIONS  
IN MISSION ORIENTED PROTECTIVE POSTURE

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Summary

Task	Correction factor	Probable range
Install generator	1.4	0.9 - 1.8
Camouflage trailer	1.3	1.2 - 1.5
Camouflage truck	1.0	1.0 - 1.2
Install antenna	0.9*	* - 1.0
Install AN/GRC 106	0.8*	a - 1.1
Install AN/MRC 138	0.7*	* - 1.1
Remove RATT	1.2	1.0 - 1.3
Remove antenna	1.3	1.1 - 1.5
Remove trailer	1.2	1.0 - 1.3

\* Probably not degraded.



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## 1. INTRODUCTION

1.1 Background. Personnel performance degradation due to wearing chemical or individual protective equipment (IPE) concerns military commanders. This concern is particularly true of signal operations, often considered a vital ingredient to a successful battle. Protective equipment is generally worn in one of four configurations referred to as Mission Oriented Protective Posture (MOPP) levels. The highest protective level, MOPPIV, in which all equipment is worn and sealed, is also the most bulky, cumbersome, and restrictive mode. Personnel are protected at the expense of this encumbrance that impedes physiological functions such as vision, hearing, speaking, and manual dexterity. Increased time to complete tasks and, in some cases, reduced accuracy result. For the purposes of this evaluation, time to complete a task was the only factor used in determining personnel degradation when wearing MOPPIV. To quantify this degradation for the commander's use in simulations, war gaming, and other studies of unit effectiveness and combat readiness, field studies are necessary.

The current evaluation was performed in response to a requirement submitted to the Chemical and Biological Joint Contract Point and Test Program (administered by the Dugway Proving Ground (DPG)), referred to as DO-49, to determine the effect of MOPPIV on personnel performing Radio Teletypewriter (RATT) tasks. The U.S. Army Ballistic Research Laboratory (BRL) was contracted to make an evaluation of the performance decrement.

Interpreting field data quantifies the degradation. It is not unusual to find subjective judgements made on the effect wearing IPE has on individual performance. One purpose of this evaluation is to provide a numerical estimate of the performance decrement resulting from wearing IPE.

This report presents the results of selected RATT operations conducted at Camp LeJune, NC, in March through April 1985. Summer conditions resulted in a temperature range of 17-25° C with an average temperature of 20.6° C. The relative humidity (RH) ranged from 30 % to 54 % with an average RH of 44.9 %. A summary of the temperature and relative humidity is included in Appendix A. Trials were performed by members of the Reconnaissance Battalion, 2nd Marine Division, Fleet Marine Force. The operation was assisted by two organizations, the Lockheed Engineering and Management Service Company and Andrullis Research Corporation who cooperated in collecting the data and providing videotape coverage of all trials. Trials were performed during the daylight hours. Teams remained in MOPPIV without relief for each trial.

1.2 Objective. The primary objective of this evaluation was to monitor the operational capabilities of a RATT team and to quantify the performance degradation while wearing MOPPIV.

## 2. APPROACH

2.1 Overview. The measure of personnel performance degradation for each task was the time difference between performing the task in battle dress uniform (BDU) and MOPPIV. For these trials, there were four teams for each task. A trained military observer (Senior NCO) timed each task and rated the overall operation. The tasks were measured in real time and recorded on a data sheet by the observer.

Individuals were trained in the appropriate military operational specialty (MOS) and were highly motivated. Teams did not have prior experience working together or prior practice before completing the first trial. Teams were familiar with chemical IPE, but received no special training or prior instruction for wearing it or for completing the above tasks in MOPPIV.

Since tasks were repetitive, individuals gained experience as they progressed through the trials. In an effort to control and later estimate the experience effect, the order of start was recorded (i.e. whether a team was in BDU or MOPPIV the first time it performed a trial.) For the purposes of this analysis, all references to "first time effect" pertain to the first trial for each team.

For each trial, the task completion time, the protective profile (BDU/MOPP), and the trial order were recorded (Appendix B).

A multiple linear regression technique was used to estimate the effect that chemical IPE and task repetition or experience had on the performance time.<sup>1</sup> This methodology provided a means to separate the effect wearing MOPPIV has on performance and the learning-curve effect that completing multiple trials has on experience.

2.2 Trial description. The trials were designed to collect performance data on RATT teams conducting a RATT mission consisting of installing and removing the various components of a RATT operation. Messages were sent after the RATT equipment was assembled and operational. The RATT message traffic was analyzed in a separate effort;<sup>2</sup> a summary of the analyses is given in Appendix C. Tasks were divided into two functional areas; the first was the installation and removal of the equipment, and the second was the sending of the RATT messages. The following tasks were completed:

1. Install generator
2. Camouflage trailer
3. Camouflage truck
4. Install antenna
5. Install AN/GRC 106
6. Install AN/MRC 138
7. Remove RATT
8. Remove antenna
9. Remove trailer

2.2.1 Equipment tasks. The sequence of events for establishing a RATT station included unpacking the electronic equipment; installing the generator; installing the antenna; placing camouflage over the tent, quarter-ton truck, and generator; establishing the radio link, and removing all the equipment and preparing it for travel.

2.2.2 Send messages. After the equipment is connected and tuned it is ready for sending RATT messages. The message traffic consisted of standard 50-word message sets. Each of 20 different sets was transmitted to a remote receiver with a hard copy retained for evaluation. Several messages were sent by each operator. The words and time required for sending the message sets were collected for analysis.

### 2.3 Trial matrix and questionnaire.

2.3.1 Trial matrix. The order of start was recorded to assist in determining the effect of training on performing the various tasks. The trial matrix indicating the day, the team, and the uniform worn is given in Table 1.

2.3.2 Survey. At the conclusion of a trial completed while wearing MOPPIV, individuals were asked to complete a questionnaire. Each was asked to rate the perceived difficulties encountered while wearing the mask, boot, and overgarment. The items to be rated are given in Table 2. Ratings were determined by checking one of four boxes: none, minor, average, and major. Each box later received a numerical weight of 0, 5, 10, and 15, respectively, for further analysis.

TABLE 1. Trial Matrix.

Day	Team	Uniform
26 March	1	BDU
26 March	2	MOPPIV
27 March	1	MOPPIV
27 March	2	BDU
28 March	1	MOPPIV
28 March	2	MOPPIV
29 March	3	MOPPIV
29 March	4	BDU
1 April	3	MOPPIV
1 April	4	MOPPIV
2 April	3	BDU
2 April	4	MOPPIV

TABLE 2. Participant Questionnaire.

Number	Situation
1	Mask-vision hampered
2	Mask-perspiration buildup
3	Mask-breathing difficult
4	Mask-voice communication
5	Boots-movement difficulties
6	Boots-slipping
7	Gloves-operating equipment
8	Gloves-performing tasks
9	Overgarment-bulkiness
10	Overgarment-heat buildup

### 3. FIELD DATA

The recorded times for the individual tasks for each item of equipment are reported in Appendix B. In reporting the data, three indicators were used to identify the type of uniform. The first is BDU and the second is MOPPIV, referring to the first trial in which a team wears chemical protective gear, and the third is MOPPIV-L, referring to the second time (day) a team wears chemical IPE. Team numbers ending in B, M, and L reflect this distinction. Thus, a code of A1-1B represents team A, first day, first time while wearing BDU; a code of A2-2M represents team A, second day, second time while wearing MOPPIV, and A3-1L represents team A, third day, first time while wearing MOPPIV, second day team has worn MOPPIV.

### 4. ANALYSIS AND DISCUSSION

A regression analysis was used to analyze the RATT data.<sup>1</sup> This section presents regression analyses for each task performed during the night reconnaissance mission. In addition, the questionnaire responses are presented and discussed.

**4.1 Analysis.** Tasks were analyzed using the regression technique according to the formula:  $T = T_0 + a + b + e$ , where  $T$  is the time to complete the task;  $T_0$  is the practiced, unencumbered term;  $a$  is the clothing correction, and  $b$  is the training correction. The results of these calculations are given in Table 3. The MOPPIV degradation factor for any particular task is defined as  $T_0 / (T_0 + a)$ . The MOPPIV correction factor (CF) is the inverse of this term and is used to multiply the time to complete a task while wearing BDUs to give an estimate of the time to complete the task while wearing MOPPIV. A negative  $a$  or  $b$  indicates that a task was completed in less time by a team wearing MOPPIV or by an unpracticed team, respectively. Generally, such results are attributed to noncorrectable inconsistencies in a team's performance for that task.

**4.2 Discussion.** All the tasks attempted while teams were wearing MOPPIV could be completed with apparent ease. The most difficult RATT task to complete was the preparation of the teletype equipment itself. Setting the equipment into operation required a CF of 1.3 - 1.6. This equipment requires attaching several connections and coordinating multiple pieces of equipment. Electrical connections could be redesigned, thus reducing this decrement.

Performance of several tasks were not degraded while soldiers were wearing IPE. Installation time for the generator equipment and removing and packing the entire operation were not degraded.

TABLE 3. Regression Results.

Task	Term, $T_o$	Clothing correction, a	Training correction, b	MOPPIV factor, CF
Install AN/GRC 106	8.9	$-1.5 \pm 2.18$	$12.6 \pm 3.74$	0.82 1.07 - 0.58
Prepare generator	6.1	$2.2 \pm 2.65$	$24.6 \pm 4.31$	1.36 1.79 - 0.92
Camouflage trailer	6.7	$1.1 \pm 0.88$	$-4.6 \pm 1.44$	1.33 1.46 - 1.20
Camouflage truck	11.4	$1.0 \pm 1.67$	$8.0 \pm 2.71$	1.01 1.24 - 0.94
Emplace antenna	3.72	$-0.5 \pm 0.50$	$1.7 \pm 0.81$	0.88 1.01 - 0.75
Remove antenna	2.2	$0.6 \pm 0.44$	$1.8 \pm 0.64$	1.27 1.48 - 1.07
Breakdown RATT	4.1	$0.6 \pm 0.59$	$4.8 \pm 0.93$	1.16 1.30 - 1.01
Breakdown trailer	2.6	$0.4 \pm 0.39$	$1.9 \pm 0.66$	1.15 1.31 - 0.98
Install AN/MRC 138	1.7	$-0.5 \pm 0.78$	$4.7 \pm 1.23$	0.71 1.12 - 0.25

Erecting the camouflage screen over the generator and quarter-ton truck is a task performed by most military units. The camouflage task was nearly as difficult as setting up and operating the RATT equipment with a CF of 1.2 and a range of 0.9 - 1.6, including both vehicles.

Other minimally degraded tasks were observed during the exercise. The ribbon on the RATT requires replacement from time to time. This is not a cartridge ribbon but rather a spool type. The operator is required to thread this ribbon onto the equipment for proper operation. It was noticed on several occasions that the ribbon would unwind or become twisted. Operators would then rewind the ribbon using a paper clip and pencil as the ribbon became unusable if not wound correctly. Further,

the teletype required tuning with a tuning fork to set it properly for sending messages. This operation required the technician to sound the fork, listen, and observe the equipment while making the tuning adjustment. All these tasks were performed with minimal degradation from the IPE.

Radio equipment used was standard TOE issue. This type, in general, is old equipment and not frequently used. When possible the communications unit uses new modular gear, which is much less labor-intensive during set up and operation. The status of equipment could also explain a certain unfamiliarity with the gear and the CFs required for setting it into operation.

4.3 Survey questions. Responses from each individual were weighted by giving a numerical value to the response terms accordingly: none = 0, minor = 5, average = 10, and major = 15. The average was then determined to estimate the level of perceived difficulty due to each factor. Results indicate (Table 4) that heat buildup in the overgarment and perspiration buildup in the mask were primary concerns.

Results were averaged for two groups, the first was the RATT operators (RTO) and the second was the radio operator (RO). The difference between these groups is their location and functions during operations. The RATT operators are located in a tent, while the radio operator is located in a quarter-ton truck under the camouflage screen. It is interesting to note that neither group were particularly concerned about the IPE.

## 5. SUMMARY AND CONCLUSIONS

The quantification of the degradation of personnel performing in MOPPIV was determined for each RATT task. The inverse of the degradation is the MOPPIV CF presented in Table 5. The multiplication of the time required to perform a task by this factor, while wearing BDU, produces an estimate of the time required to complete the task while wearing MOPPIV.

All observed tasks were completed while wearing MOPPIV with little additional time required due to the IPE. Observations included other tasks that were completed but not timed. Rewinding and replacement of the teletype ribbon, tuning the teletype (a process which utilizes a turning fork) and several similar tasks of importance to the operation, but of short duration, were repeated during the study and completed with little apparent decrement.

TABLE 4. Signal Operations Questionnaire Results (Wearing MOPPIV).

Factor	Team average					
	A2 - 1M		A3 - 1L		B1 - 1M	
	RTO	RO	RTO	RO	RTO	RO
Mask/vision	-	4	-	4	-	1
Mask/water buildup	-	5	-	6	-	7
Mask/breathing	-	4	-	4	-	0
Mask/commo	-	5	-	5	-	3
Boots/movement	-	3	-	4	-	1
Boots/slipping	-	3	-	4	-	1
Gloves/operating equipment	-	6	-	6	-	3
Gloves/tasks	-	6	-	7	-	3
Overgarment/bulkiness	-	3	-	5	-	3
Overgarment/heat buildup	-	8	-	7	-	8
AVERAGE	-	4.7	-	5.2	-	3.0
	B3 - 4L		C1 - 1M		C2 - 4L	
	RTO	RO	RTO	RO	RTO	RO
Mask/vision	-	1	5	2	4	2
Mask/water buildup	-	8	7	4	5	4
Mask/breathing	-	1	2	1	2	1
Mask/commo	-	2	5	3	3	1
Boots/movement	-	1	6	2	5	4
Boots/slipping	-	1	1	1	2	3
Gloves/operating equipment	-	5	8	3	6	3

TABLE 4. (Con't)

Factor	Team Average					
	B3 - 4L		C1 - 1M		C2 - 4L	
	RTO	RO	RTO	RO	RTO	RO
Gloves/tasks	-	5	7	2	6	5
Overgarment/bulkiness	-	3	6	2	4	2
Overgarment/heat buildup	-	7	10	8	7	5
AVERAGE	-	3.4	5.7	2.8	4.4	3.0
	D2 - 4M		D3 - 4L		Average for all teams	
	RTO	RO	RTO	RO	RTO	RO
Mask/vision	1	5	2	3	3	3
Mask/water buildup	5	5	4	6	5	6
Mask/breathing	1	8	2	3	2	2
Mask/commo	4	3	3	5	4	3
Boots/movement	2	8	3	5	4	3
Boots/slipping	2	7	2	3	2	3
Gloves/operating equipment	4	3	3	2	6	5
Gloves/tasks	4	2	3	2	5	4
Overgarment/bulkiness	4	7	3	5	4	4
Overgarment/heat buildup	5	6	4	6	7	7
AVERAGE	3.2	5.4	2.9	4.0	4.2	4.0

TABLE 5. MOPPIV Correction Factors.

Task	Factor	Probable range
Install generator	1.4	0.9 - 1.8
Camouflage trailer	1.3	1.2 - 1.5
Camouflage truck	1.0	1.0 - 1.2
Install antenna	0.9*	0.8 - 1.0
Install AN/GRC 106	0.8*	0.6 - 1.1
Install AN/MRC 138	0.7*	0.3 - 1.1
Remove RATT	1.2	1.0 - 1.3
Remove antenna	1.3	1.1 - 1.5
Remove trailer	1.2	1.0 - 1.3

\* Probably not degraded.

## 6. REFERENCES

1. Wick, C. H., Morrissey, J. A., and Klopchic, J. T., "Maintenance Operations in Mission Oriented Protective Posture Level IV (MOPPIV)." USA BRL-MR-3629, October 1987.
2. Wadsworth, H., Coindreau, A., and Naigle, R., "Degration of Radio Teletype Operations in a Chemical Environment." Special project completed at the Georgia Institute of Technology, 1986.

APPENDIX A

CLIMATIC CONDITIONS

## Daily Temperature and Relative Humidity Record

During the exercise the temperature and relative humidity as well as the general atmospheric condition were recorded in 30-minute intervals. The high, low, and average temperature and relative humidity are given in Table A-1.

TABLE A-1. Daily Temperature and Relative Humidity.

Day	Temperature, °C			Relative humidity, %		
	High	Low	Average	High	Low	Average
26 Mar 85						
Team 1	23	11	17	81	24	45
Team 2	18	13	15	56	32	43
27 Mar 85						
Team 1	23	11	20	82	36	48
Team 2	22	13	20	72	38	49
28 Mar 85						
Team 1	26	17	23	65	44	52
Team 2	28	17	23	67	46	54
29 Mar 85						
Team 3	29	21	25	62	43	52
Team 4	28	21	25	62	48	55
01 Apr 85						
Team 3	25	17	22	54	20	34
Team 4	25	17	22	50	19	30
02 Apr 85						
Team 3	20	13	18	44	23	36
Team 4	19	15	17	47	28	41
AVERAGE	23.8	15.5	20.6	61.8	33.4	44.9

APPENDIX B

FIELD DATA

TABLE B-1. Field Data Summary.

Team	Day	Task time, min		
		Install AN/GRC 106	Prepare generator	Camouflage net trailer - truck
A1 - 1B	26 Mar 85	26.0	46.6	8.1 - 14.8
A1 - 2B		12.5	7.5	12.8 - 13.2
A1 - 3B		10.2	5.2	9.6 - 16.7
A2 - 1M	27 Mar 85	9.8	7.4	8.9 - 11.6
A2 - 2M		8.8	6.5	7.0 - 13.4
A2 - 3M		6.4	5.5	12.0 - 12.6
A3 - 1L	28 Mar 85	13.0	9.7	5.9 - 9.8
A3 - 2L		5.9	5.3	7.9 - 8.4
A3 - 3L		4.0	4.8	6.4 - 11.7
A3 - 4L		3.3	4.4	8.9 - 7.7
B1 - 1M	26 Mar 85	---	59.0	21.0 - 14.0
B1 - 2M		---	23.2	8.0 - 25.0
B1 - 3M		---	17.5	9.2 - 25.2
B2 - 1B	27 Mar 85	---	11.7	8.8 - 11.5
B2 - 2B	27 Mar 85	---	9.2	8.8 - 16.5
B2 - 3B		---	12.1	12.1 - 12.7
B3 - 1L	28 Mar 85	---	11.8	9.4 - 9.6
B3 - 2L	28 Mar 85	---	9.1	11.7 - 11.3
B3 - 3L	28 Mar 85	---	9.9	9.9 - 6.7
B3 - 4L	28 Mar 85	---	6.9	8.1 - 10.7
C1 - 1M	29 Mar 85	15.6	8.4	15.4 - 30.0
C1 - 2M	29 Mar 85	6.6	3.2	7.9 - 12.5
C2 - 1L	01 Apr 85	15.4	8.6	10.1 - 12.5
C2 - 2L	01 Apr 85	5.9	6.0	9.3 - 10.8
C2 - 3L	01 Apr 85	5.5	4.7	8.1 - 10.7
C2 - 4L	01 Apr 85	8.0	3.0	9.2 - 7.4
C3 - 1B	02 Apr 85	5.2	2.1	3.2 - 7.9
C3 - 2B	02 Apr 85	3.1	2.6	5.4 - 14.5
C3 - 3B	02 Apr 85	5.3	2.8	6.3 - 8.4
C3 - 4B	02 Apr 85	3.4	2.5	3.5 - 7.5
C3 - 5B	02 Apr 85	4.5	1.5	6.5 - 6.4

TABLE B-1. (Con't)

Team	Day	Task time, min		
		Install AN/GRC 106	Prepare generator	Camouflage net trailer - truck
D1 - 1B	29 Apr 85	---	13.3	5.3 - 20.8
D1 - 2B	29 Apr 85	---	8.5	6.6 - 15.8
D1 - 3B	29 Apr 85	---	8.3	6.8 - 12.0
D1 - 4B		---	7.0	6.6 - 7.8
D2 - 1M	01 Apr 85	---	11.1	10.5 - 22.3
D2 - 2M	01 Apr 85	---	8.2	9.8 - 15.3
D2 - 3M	01 Apr 85	---	7.8	8.2 - 17.1
D2 - 4M	01 Apr 85	---	14.3	5.7 - 11.0
D2 - 3L	02 Apr 85	---	3.7	7.5 - 5.7
D3 - 4L	02 Apr 85	---	5.4	6.5 - 4.8
		Whip antenna emplace-remove	Breakdown RATT-trailer	Install AN/MRC 138
A1 - 1B	26 Mar 85	5.7 - 3.4	8.3 - 2.9	9.8
A1 - 2B	26 Mar 85	4.5 - 2.8	4.8 - 1.8	2.5
A1 - 3B	26 Mar 85	4.5 - 1.6	4.4 - 3.5	3.2
A2 - 1M	27 Mar 85	3.9 - 4.0	10.1 - 4.9	3.3
A2 - 2M	27 Mar 85	3.4 - 2.5	3.9 - 2.3	2.8
A2 - 3M	27 Mar 85	3.4 - 3.0	3.7 - 1.7	1.5
A3 - 1L	28 Mar 85	4.4 - 1.6	5.5 - 2.4	1.3
A3 - 2L	28 Mar 85	1.9 - 2.1	4.8 - 3.1	0.9
A3 - 3L	28 Mar 85	2.4 - 2.1	3.2 - ---	2.1
A3 - 4L	28 Mar 85	1.5 - 1.5	4.4 - 3.3	0.7
B1 - 1M	26 Mar 85	4.0 - 7.5	13.3 - 7.0	---
B1 - 2M	26 Mar 85	4.5 - 2.9	3.3 - 4.3	---
B1 - 3M	26 Mar 85	3.8 - 3.7	4.8 - 5.4	---
B2 - 1B	27 Mar 85	2.9 - 2.4	6.7 - 3.4	---
B2 - 2B	27 Mar 85	8.6 - 1.8	4.9 - 3.2	---
B2 - 3B	27 Mar 85	4.6 - 2.2	4.2 - 3.7	---

TABLE B-1. (Con't)

Team	Date	Task Time, min		
		Whip antenna emplace-remove	Breakdown Ratt-trailer	Install AN/MRC 138
B3 - 1L	28 Mar 85	2.0 - 1.6	5.1 - 3.6	---
B3 - 2L	28 Mar 85	2.1 - 1.8	3.9 - 3.3	---
B3 - 3L	28 Mar 85	3.4 - 1.4	3.2 - 3.1	---
B3 - 4L	28 Mar 85	2.9 - 1.9	3.6 - 3.5	---
C1 - 1M	29 Mar 85	5.0 - 3.0	6.3 - 3.9	2.5
C1 - 2M	29 Mar 85	2.7 - 2.0	6.4 - 2.9	0.7
C2 - 1L	01 Apr 85	2.9 - 3.4	9.5 - 2.0	---
C2 - 2L	01 Apr 85	4.8 - 1.9	4.6 - 1.4	---
C2 - 3L	01 Apr 85	2.7 - 2.1	3.4 - 1.8	---
C2 - 4L	01 Apr 85	2.3 - 2.1	3.9 - 1.9	1.0
C3 - 1B	02 Apr 85	2.0 - ---	3.0 - ---	0.6
C3 - 2B	02 Apr 85	1.4 - ---	4.0 - 3.2	0.8
C3 - 3B	02 Apr 85	2.1 - ---	2.5 - 1.0	0.5
C3 - 4B	02 Apr 85	1.5 - 1.0	2.5 - 1.1	0.5
C3 - 5B	02 Apr 85	0.9 - 1.2	3.2 - 0.8	0.5
D1 - 1B	29 Apr 85	5.9 - 3.3	9.1 - 5.2	---
D1 - 2B	29 Apr 85	6.4 - 4.2	4.5 - 5.5	---
D1 - 3B	29 Apr 85	4.8 - 3.5	4.7 - 2.8	---
D1 - 4B	29 Apr 85	2.7 - ---	--- - ---	---
D2 - 1M	01 Apr 85	5.8 - ---	--- - ---	---
D2 - 2M	01 Apr 85	4.5 - 4.5	4.0 - 3.1	---
D2 - 3M	01 Apr 85	3.1 - 4.5	4.6 - 2.3	---
D2 - 4M	01 Apr 85	--- - 4.7	3.3 - 3.9	---
D2 - 3L	02 Apr 85	3.2 - 3.6	4.7 - 3.5	---
D3 - 4L	02 Apr 85	4.5 - ---	4.3 - 2.5	---

APPENDIX C

SUMMARY OF ANALYSIS OF TELETYPE MESSAGES  
SENT WHILE WEARING MOPPIV

The degradation of RT operator performance is a concern to military operations because of the importance of the communication link in commanding and controlling field forces. Accuracy in communications is of particular importance since slight deviations from the original message can result in a totally different intent. For instance, an error in a unit designation can cause the wrong unit to be committed to battle; an error in a national stock number could result in the wrong item being requisitioned. Likewise, an error in grid coordinates may result in confusion, delayed actions, or cancellation of planned actions or bombardment of the friendly positions. The RT operator wearing MOPPIV is hindered by three items: a protective mask, a protective hood, and a pair of rubber gloves. A typist in this configuration is simultaneously affected by all three items. The mask affects visual acuity; the hood, hearing; and the gloves, tactile capability and dexterity of the hands. It should be noted that operators were instructed to take as long as necessary to complete the task while maintaining accuracy. The measure of degradation is, thus, the increased time to send a message. As a result, messages were examined with particular scrutiny.

#### Methodology

Messages were collected from each of four teams as they operated the RATT equipment. Each team consisted of a RATT operator who typed out the message traffic. Each team completed at least one (and up to five) trial in each of three uniform designations: BDU, MOPPIV, and MOPPIV-L. Normally 10 messages (50-word lists) randomly selected from a control group of 20 messages were typed in each trial.

Error was defined as an incorrect keystroke or sequence of keystrokes. For each list of 50 words, a maximum of 50 errors are possible. General categories selected are: spelling error, spacing error, and combined spacing/spelling error.

The measure of speed and accuracy was words per minute, selected because it measures both the speed and the accuracy of the work. A corrected rate was used for analyses and determined by dividing the number of words typed correctly in a message by the number of minutes required. An average typing rate for RTT operators is then determined for both BDU and MOPPIV conditions. The ratio of the rates then gives a measure of degradation.

## Results

A total of 770 messages was available for analysis. Analysis was accomplished using standard statistical procedures including means and a regression analysis. Outputs included standard parameters, an ANOVA, and residual plots.

The proficiency ranged from 13.6 wpm to 50.4 wpm for teams wearing BDU. The effectiveness of a typist of 30 wpm is 0.7; the inverse is the correction factor or 1.4, that value used to multiply the time to send a message in BDU, which estimates the time to send the message while wearing MOPPIV.

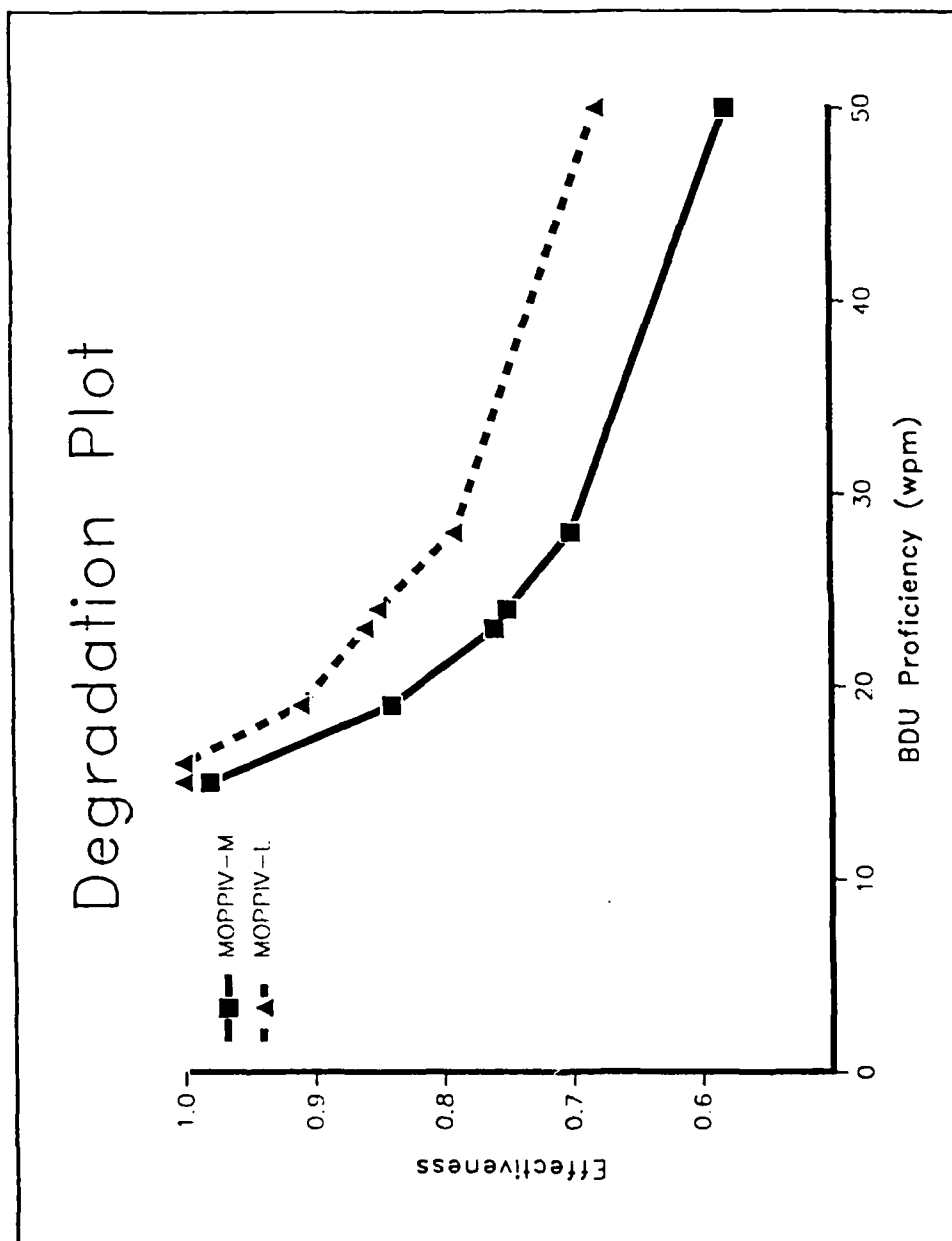


Figure C-1. Degradation plot for teletype operation wearing mission-oriented protective posture level IV (MOPPIV). MOPPIV-L equals a trained condition.

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